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ABSTRACT

This module utilizes hole punching with a pencil, paper folding, rubber band stretching, and unique bcard models to "picture" key geometric concepts in an intuitive manner. The module is virtually self-contained, except for common classroom items which are scissors and a protractor. The introductory lesson allows for a variety of approaches for the student to take as he/she experiments and looks for solutions to divergent questions. The five experiments involve inexpensive models which help the student build up a concept of key geometric ideas in a very concrete way. The module contains five enrichment cards, which involve students in problem situations that require the use of at least some of the geometric concepts stressed in the module. (Author/MK)

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TYPICAL MODULE FOR USE
IN A
MATHEMATICS LABORATORY SETTING

TOPIC: Intuitive Geometry

by

Lyle Andersen

A Publication
of
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Dr. Ruth I. Hoffman, Director

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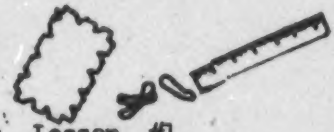
SE 030 316

TEACHER"S GUIDE

"Building" Ideas - INTUITIVE GEOMETRY

This module may be used in a variety of ways.

1. It may be used with a pretest, as suggested in the teacher's guide.
2. Groups of students may be assigned to various experiments according to past performance.
3. The class may be divided so each group has a group leader who has the ability to help the other students.
4. Teachers may use a group-method of their own choosing.
5. Teachers may use it with the entire class.



Materials

.Contained in this module:

1. Tagboard metric ruler (Int. Lesson, #1, #2, and #3).
2. Tagboard of jigsaw puzzles (1#1A)
3. Colored construction paper (#2A)
4. Six "likesized" rubber bands (#3A and #4A)
5. Heavy corrugated cardboard for geo-snap board. (#4A)

.Teachers must provide:

1. Three sheets of paper (Int. lesson)
2. Scissors (#1A, #2A, and #4A)
3. Protractor (#4A)

.Optional (teacher provides)

1. Cardboard, Enrichment Card #5.

During field testing, this complete module took an average of ____ fifty-minute periods to complete. TG-

OBJECTIVES

.Given instructions on how to construct a polygon, the student will be able to complete the construction and measure its perimeter with a metric ruler.

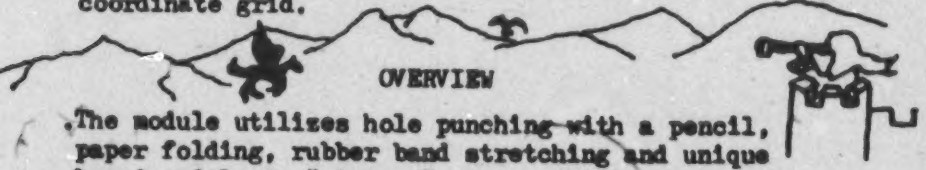
.Given a set of polygonal shapes, the student will use these to build a parallelogram, rectangle, and hexagon and will measure the perimeter of each polygon.

.By paper folding, students will construct a box representing a polyhedron. They will also perform area and volume measurements using both direct and indirect methods.

.Given instructions, students will be able to use a simple pantograph to draw enlargements. They will also make comparisons of the similar drawings by using ratios.

.Given a geo-snap board, students will measure angles with a protractor and they will be able to identify angles as being acute, right or obtuse. Given directions, they will also construct certain geometric shapes.

.Given Pick's Law, students will be able to determine areas of polygons which are located on a right-coordinate grid.



OVERVIEW

.The module utilizes hole punching with a pencil, paper folding, rubber band stretching and unique board models to "picture", in an intuitive manner, key geometric concepts.

.The module is virtually self-contained, except for common classroom items which are scissors and a protractor. The introductory lesson allows for a variety of approaches for the student to take as he experiments and looks for solutions to divergent questions. The five experiments involve inexpensive models which help the student build

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up a concept of key geometric ideas in a very concrete way.

The module contains five enrichment cards, which involve students in problem situations that require the use of at least some of the geometric concepts stressed in the module.

TESTING PROCEDURE

I. Pretest

A. The pretest checks the behavior entry level of the students to determine if they need additional preparation before beginning work on this module.

B. If the student is unsuccessful on the pretest, then s(he) should be directed to pre-module materials.

II. Pre-Module Experiences

A. Students whose scores on the entry level test indicate they need additional preparation will likely profit most from the use of concrete materials which they build themselves, such as those in the introductory lesson.

B. Those who have difficulty with metric measurement may need individual help and carefully supervised practice.

III. Posttest

A. The posttest checks to see if the student is able to successfully complete the objectives established for this module.

OUTLINE

I. Introduction Lesson

A. Teaching suggestions

1. Students enjoy doing this lesson in pairs.

2. Students who experienced difficulty with the pretest might be paired with a student who will help them as needed.

3. You may prefer to complete this lesson as an entire class project.

B. Materials supplied

1. Each student needs to be supplied with three sheets of paper and a metric ruler similar to the one supplied with this module.

2. Provide students with the introductory activity card and worksheet.

C. Work to be completed by the student

1. Introductory worksheet

You may prefer to cut out and laminate the answer key below so students can verify their work.

- - - -

II. Experiment #1

A. Teaching suggestions

1. Students should be encouraged to complete this experiment by themselves.

2. You may wish to suggest to students that they build polygons other than those pictured.

3. You may prefer to complete this lesson as an entire class project.

B. Materials supplied

1. Provide students with Activity Card #1 and worksheets #1A and #1B. You may, if it is an entire class project, simply read the directions on the activity card.

C. Work to be completed by the students

1. #1A and #1B.

Answer Key - #1B - Intuitive Geometry

1. Approx. 312 mm.
2. Approx. 338 mm.
3. Approx. 234 mm.
4. Answers will vary. Students might verify each other's work.

TG-

II. Experiment #2

A. Teaching suggestions

1. Students who have difficulty with space conceptions may need step-by-step help with this experiment.

2. The teacher should go through the activity before allowing students to complete it. By doing this, many other important geometric concepts can be brought to the students' attention if the teacher desires to do this.

3. This is a highly motivational lesson, and the teacher may prefer to complete it as an entire class project.

B. Materials supplied

1. Activity Card #2 and worksheet #2.

2. 1 sheet of colored construction paper (20 cm. x 20 cm.)

3. Scissors.

C. Work to be completed by the student

1. Students will be expected to follow directions and complete the construction of the box.

2. They will also answer as many of the questions on #2A as the teacher deems feasible.

Answer Key - #2A - Intuitive Geometry

1) 100 sq. cm. 2) 50 sq. cm.
3) 12.5 sq. cm. 4) 176.846 cu. cm.
5) Definition of a parallelepiped
6) 200 sq. cm., if only the 6 surfaces are counted.
7) 50 sq. cm.
8) 42.76 in. x 42.76 in.

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IV. Experiment #3

A. Teaching suggestions

1. Most students should be able to complete this experiment with a minimum of help. If students make more exotic enlargements, then it is helpful to have them tape down their paper with masking tape.

2. Making enlargements on the chalkboard is an excellent way to show comparisons of similar figures.

3. You may prefer to complete this lesson as an entire class project.

B. Materials supplied

1. Activity Card #3 and worksheet #3A

2. 4 like-sized rubber bands

3. Paper to do additional drawings (opt.)

C. Work to be completed by the student

1. Students will be expected to follow directions and complete #3A.

2. They will also answer as many of the questions on #3A as the teacher deems feasible.

Answer Key - #3A - Intuitive Geometry

1) Show a 2 cm. by 2 cm. square.
2) Show the enlarged square.
3) 4 cm.
4) 4 cm.
5) Answers will vary, depending on what height is used. The height and length each have doubled.
6) The ratio will be 3 to 1. Answers will vary.

V. Experiment #4

A. Teaching suggestions

1. This device works well in classroom presentations. Have the students "snap-on" a named angle, then make certain all the students were successful by having them hold up their cards for viewing.

2. You may prefer to have students work together on #4A.

3. It is important that students learn to estimate before they measure. This procedure should be encouraged.

B. Materials supplied

1. Activity Card #4 and worksheet #4A
2. Scissors
3. Protractor

C. Work to be completed by the student

1. Students will "snap-on" rubber bands (as directed) on the board they cut out.

2. They will then complete #4A.

Answer Key - #4A - Intuitive Geometry

1) a. acute
b. acute
c. acute
d. acute
e. obtuse
f. right

2) a. 79°
b. 34°
c. 23°
d. 42°
e. 90°
f. 90°

3) a. They are both (approx.) equal to 63°.

b. They also are equal to each other and their measurement is approximately 63°.

4) $m(\overline{WX}) \doteq 3$ inches

$m(\overline{QK}) \doteq 6$ inches. The length of WX is 1/2 of the length of $\overline{QK}$.

VI. Experiment #5

A. Teaching suggestions

1. You may prefer to have students use a geoboard and rubber bands when doing this experiment.

2. If you are working with students capable of generating fairly sophisticated thoughts, you might have them discover Pick's Law through supervised experimentation.

3. Students often have difficulty applying the data to the generalization.

4. You might use a coordinate "dot-grid" on the overhead if this experiment is used as a discovery lesson.

B. Materials supplied

1. Activity Card #5, worksheets #5A and #5B.

2. Optional (The teacher might provide geoboards for this experiment, if they are available.)

C. Work completed by the student

1. Students will count dots on a coordinate pattern and use this data to complete #5A and #5B by applying this data to Pick's Law.

Answer Key - #5A - Intuitive Geometry

Figure	Grid Points on the Polygon (p)	Grid Points inside the Polygon (i)	Area of the Polygon A
A	12	4	9
B	12	7	12
C	14	8	14
D	50	22	56
E	22	3	13

#5B

Figure	Grid Points on the Polygon (p)	Grid Points inside the Polygon (i)	Area of the Polygon A
F	6	0	2
G	6	0	2
H	4	1	2
I	11	3	$7\frac{1}{2}$
J	16	0	7
K	12	0	5

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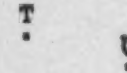
VII. Bulletin Board (Optional)

Cover the board with light-colored paper. Write the questions and sketch the figures with a felt-tipped pen.

Find the set of points that

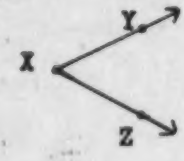
are the same distance from T and U.



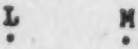
are 6 inches from Q.

are 3 inches from $\overleftrightarrow{L\,M}$.

are the same distance from $\overrightarrow{X\,Y}$ and $\overrightarrow{X\,Z}$.



are 5 inches from L and M.



are the same distance from D, E and F.

VIII. Enrichment Cards

A. Teacher suggestions

1. If the pretest was used, those students who scored 90% or higher (depending on teacher discretion) may be given an enrichment card to investigate.

2. These may be used as extension work for students who have completed the unit.

B. Answer Key

1. The Answer Key has been provided at the bottom of the enrichment card. These may be cut off before the student is given the card.

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Pretest

1. a) p = 12 in.
   A = 9 sq. in.

   b) p = 5.46 in.
   A = 2 sq. in.

   c) p = 15.6 in.
   A = 16 sq. in.

2. a) acute c) acute
   b) right d) obtuse

3. A is 3
   B is 4½
   C is 1
   D is 3

Posttest

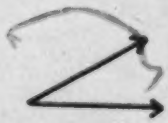
1. a) 6 cm. b) 59 mm. c) 2 inches

2. a) 47" b) 138 miles

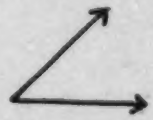
3. a) 43° c) 43°
   b) 110° d) 8°

4. a)

b)



c)



5. a) parallel
   b) perpendicular
   c) perpendicular
   d) neither
   also called
   skew lines

6. a = 18 sq. cm. $\quad$ b = $\frac{35}{36}$ sq. in.

7. a) A = $\frac{1}{2}$ x 3.5 x 1.2 = 2.1 sq. cm.
   b) A = $\frac{1}{2}$ x 7.5 x 2 = 7.5 sq. cm.

8. A = $5\frac{1}{2}$ $\quad$ B = 4 $\quad$ C = $4\frac{1}{2}$
   D = $4\frac{1}{2}$ $\quad$ E = $7\frac{1}{2}$

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Intuitive Geometry PRETEST

Name _____

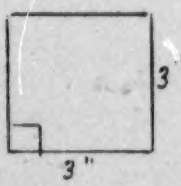
Score _____

Time _____

(10 points for each problem.)

1. Find the perimeter and area of each polygon:

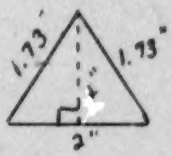
a.



perimeter =

area =

b.



perimeter =

area =

c.

perimeter =

area =

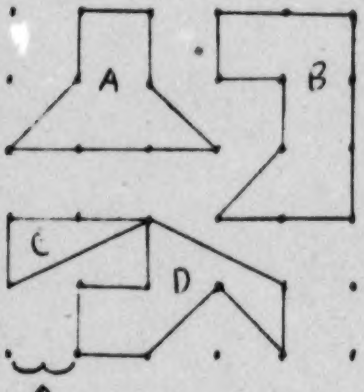
2. Correctly name the angle as a right angle, acute angle or obtuse angle.

a.

b.

c.

d.

3. 

Find the area of each figure.

a. Figure A -- Area =

b. Figure B -- Area =

c. Figure C -- Area =

d. Figure D -- Area =

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Introductory Lesson

Paper Folding and Pencil Punching

Activity Card Materials

3 sheets of paper
Metric ruler

First, fold a sheet of paper over as shown in Fig. 1. Form a "squared" piece of paper by cutting off the part which extends beyond the triangle.

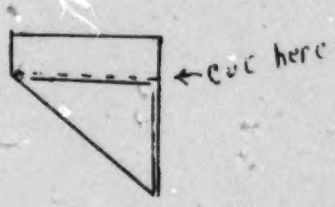

Fig. 1

The squared paper has been folded on its diagonal. Open up the square and fold on the other diagonal. Leave the paper folded and fold again on the crease formed from the first diagonal. It now looks like Fig. 2.

Fig. 2

Mark a point in the "middle" of the triangular-shaped paper. Call that Point A.

Jam your pencil through "Point A".

Complete the student worksheet which accompanies this introductory lesson.

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1. How many holes are in the squared paper? _____
   Letter the holes consecutively, A,B,C,D, starting with A.
   (Note that A has already been named.)
2. Draw line segments AB, BC, CD and DA. Name the shape formed. _____
3. Determine the perimeter (to the nearest centimeter) of the polygon, represented by the drawing.
4. Refold the paper so it again is a triangular shape. Punch another hole so the "new shape" formed by connecting these holes has a greater perimeter than the first figure.
   What is the difference (in centimeters) of the perimeters of the two shapes? _____
5. Fold another sheet of paper in such a way that when you jam your pencil through it three holes are punched, and when these holes are connected a triangular shape is formed.
   What is its perimeter to the nearest centimeter? _____
6. Refold the paper and attempt to punch a new hole to form a second triangle that has twice the perimeter of the first triangular shape. How close did you come? _____
7. A hexagon is a six-sided polygon ( ). Fold a new piece of paper in such a way that, with one punch, six holes are made. Unfold the paper and connect the six holes with line segments. Determine the hexagon's perimeter to the nearest centimeter.

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Jigsaw Puzzle Polygons

Materials

Scissors
Metric ruler

Exactly twelve different polygons can be created by using six enclosed equilateral triangles. Cut out the 12 regions on 1A.

Complete the puzzles shown on 1B.

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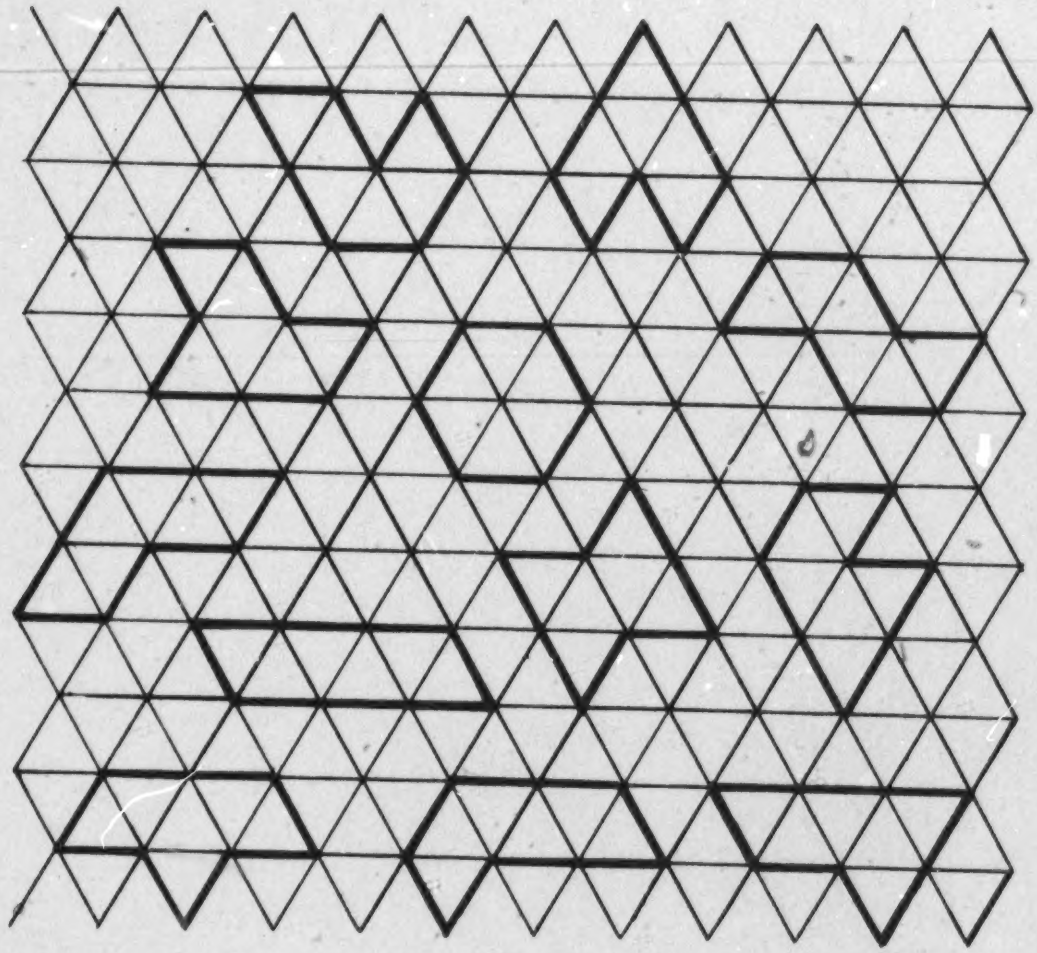
Jigsaw Puzzle Polygons

Cut out the 12 polygons.



Complete #1B.

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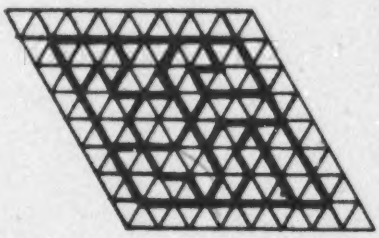
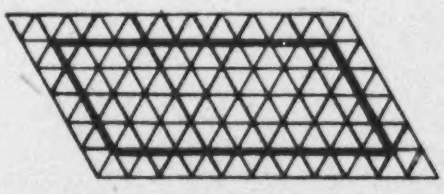
Jigsaw Puzzle Polygons

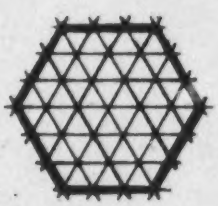
1. Use all 12 pieces to make this parallelogram. Determine its perimeter to the nearest millimeter.



2. Arrange the 12 pieces to make this parallelogram. Measure its perimeter to the nearest millimeter. _____



3. Use 9 of the pieces to make this hexagon. Measure its perimeter to the nearest millimeter. _____



4. Can you use some of the shapes to make a rectangle? Draw the rectangle showing the position of each shape.

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Materials

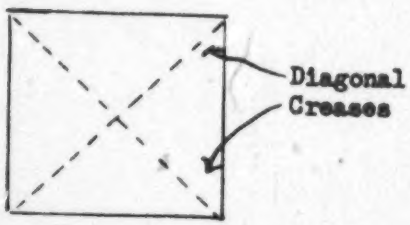
A sheet of paper

Many triangles can be created by folding a square piece of paper. Follow the directions and complete the questions on 2A.

From "2-D" to "3-D"

Crease a 20 cm x 20 cm paper on its "diagonals."

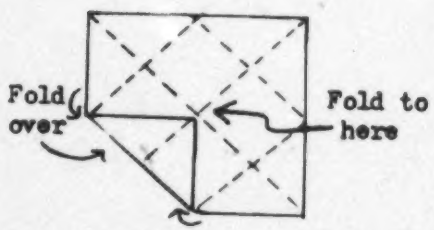
1. What is the area of one of the "triangles" formed?
_____ sq. cm. (Check by measuring.)



The formula for finding the area of a triangle is $A = \frac{1}{2} b h$ where b is the base and h is the vertical height.

Fold each "vertex" (corner of the paper) to the center (point where the diagonals intersect.)

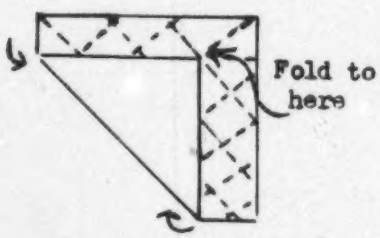
2. What is the area of one of the squares? _____ sq. cm.
(Check by measuring.)



The formula for finding the area of a square is $A = s^2$ where s is the length of a side.

Next fold each "vertex" (corner of the paper) to the crease made in the previous example. Check your work by noting if 32 small squares have been formed.

3. What is the area of one of the small squares? _____ sq. cm.



(Hint: When the smallest triangles formed by the creases are folded over, it becomes apparent that the "small squares" make up one-half of the paper.)

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Fold the paper in half, Fig. (A), along a "diagonal crease" and in half again along the other"diagonal crease". Cut out the small triangles, Fig. (B).

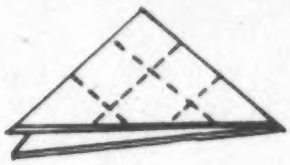

Fig. (A)

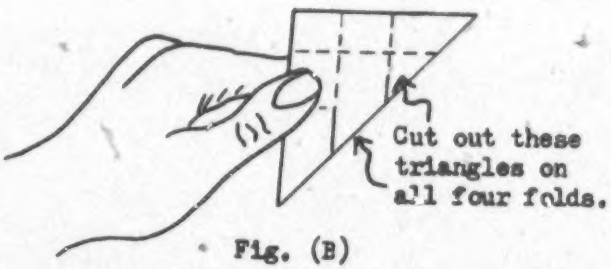

Fig. (B)

Unfold your paper and it will look like Fig. (C). Then cut slots at the places indicated on Fig. (D). Be careful these cuts must be positioned as shown.

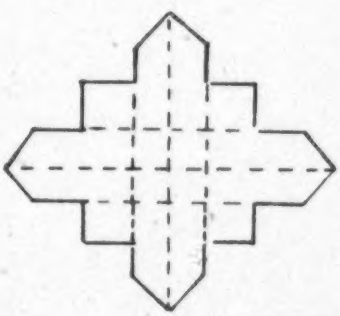

Fig. (C)

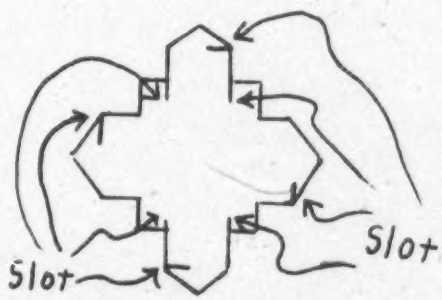

Fig. (D)

Fold the paper and interlock the tabs to form a box or three-dimensional object (Fig. F). Do this by interlocking opposite pairs of flaps and tucking the "rectangular flaps" inside the box.

4. Determine the capacity of the box in cubic centimeters.

_____cu. cm.

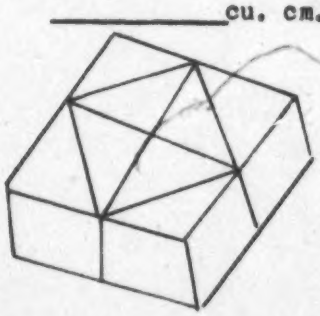

Fig. (F)

Volume (or capacity) of the box may be determined by using the formula $V = l \cdot w \cdot h$.

Where V is volume, l is length, w is width and h is height.

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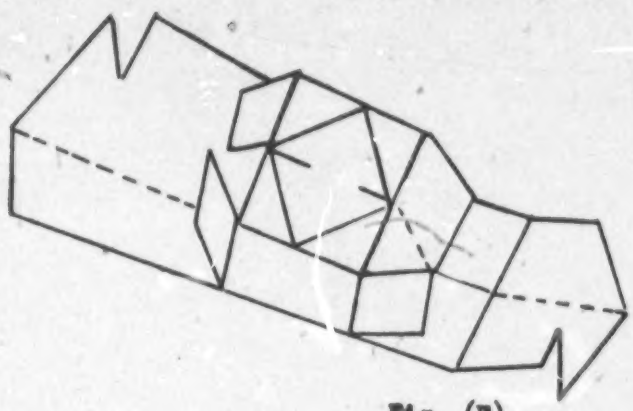

Fig. (E)

5. Geometric shapes of the kind the box is a model of, are called rectangular prisms (or another name is parallelepipeds.) Look up the definition of parallelepipeds.
6. What is the surface area of the box in square centimeters? _____ sq. cm.
7. How much paper was cut off and not used? _____
8. Determine the dimensions of a squared piece of paper that could be folded into a box with a capacity of one cubic foot? _____
9. How many of these "parallelepipeds" will it take to fill your classroom? _____

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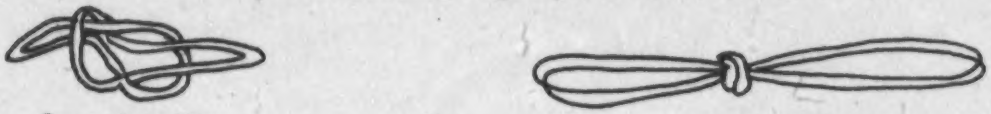
Enlarging or Shrinking

Materials

4 like-sized rubber bands

The artist's tool that enables him to easily enlarge or shrink a drawing is the pantograph. This is a commonly used device and a commercially manufactured model is easily obtainable at any commercial art store.

Build a simple pantograph by looping two "like-sized" rubber bands together, Fig. (3-1), and pulling tightly to form a knot.



Loop together then pull tightly

Fig. (3-1)

Now complete 3A.

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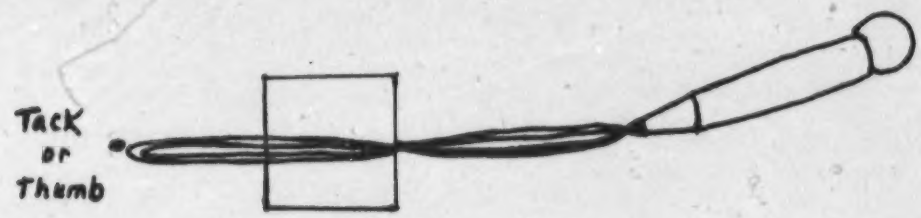
Enlarging or Shrinking

1. Draw a 2 cm. square on your paper.
2. Hold one end of the rubber band in one place, using your thumb or a thumbtack. Stretch the rubber bands so the knot is on the square. Place the point of a pencil inside the second rubber band. Let the pencil trace the curve you get when you keep the knot on the simple closed curve (square).



3. What is the height of the "large" square to the nearest centimeter? _____ cm.
4. What is the width of the "large" square to the nearest centimeter? _____ cm.
5. Trace the phantom jet on your paper. Enlarge it, using the method you used to trace the square. To the nearest centimeter, measure the height and width of the enlarged jet. Compare the ratios of height to width for both jets. What do you notice?

6. Attach a third rubber band and pull tightly to form a second knot. Trace the picture of the rock singer on your paper. Enlarge it with the rubber band tracer, placing the first knot on the tracing. To the nearest centimeter measure the height and length of the enlarged rock singer. Compare the ratios of height to width for both pictures. What do you notice?

7. Repeat Part 6, using the second knot.

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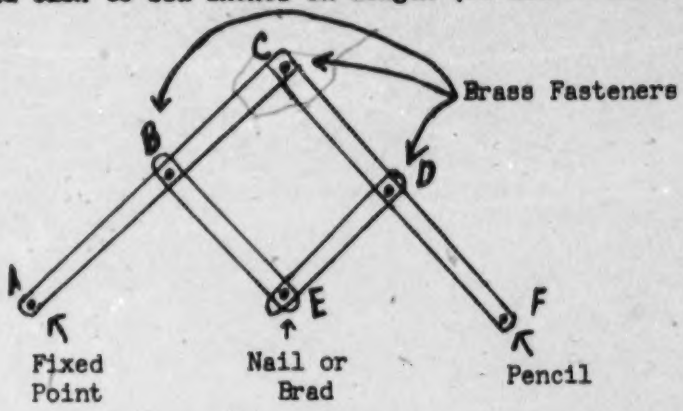
Optional

8. Another kind of pantograph uses cardboard links. Strips of heavy posterboard are excellent for making this device. Brass fasteners work well for fastening the strips together to form the linkage. For the pantograph, cut four strips of posterboard, each about one inch wide. Two of the strips should be twelve inches in length (these are AC and FC in the figure); the other two should each be six inches in length (BE and DE in the figure).



Fasten the strips of posterboard as shown in the figure. It is important that BCDE always be a parallelogram. It is not necessary to use the 2:1 ratio suggested in this illustration. The brass fasteners will allow the entire assembled linkage to move at the joints.

Problem 8 taken from: Krulik, Stephen; Handbook of Aids for Teaching Junior-Senior High School Mathematics, Philadelphia; W.B. Saunders Co. 1971, p. 76,77.

USING THE PANTOGRAPH

When using the pantograph to enlarge a picture or a drawing, keep point A fixed. Use a thumbtack to do this. Place a pencil through a hole made at point F. Push a small brad or nail through point E; this will serve as a tracing point.

After fixing point A, place a fresh sheet of paper underneath point F. Place the drawing to be copied underneath the nail at point E. Move the nail along the drawing slowly. The pencil at F will make an enlarged drawing of the picture being traced at E.

9. Enlarge the tracing of the horse with the cardboard pantograph.

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Rubber Bands and Angles

Materials

6 rubber bands
Scissors
Protractor

Cut out Figure 1 and glue it onto a piece of 50 mm x 100 mm corrugated cardboard. Cut notches at the letters to complete your geo-snap board.

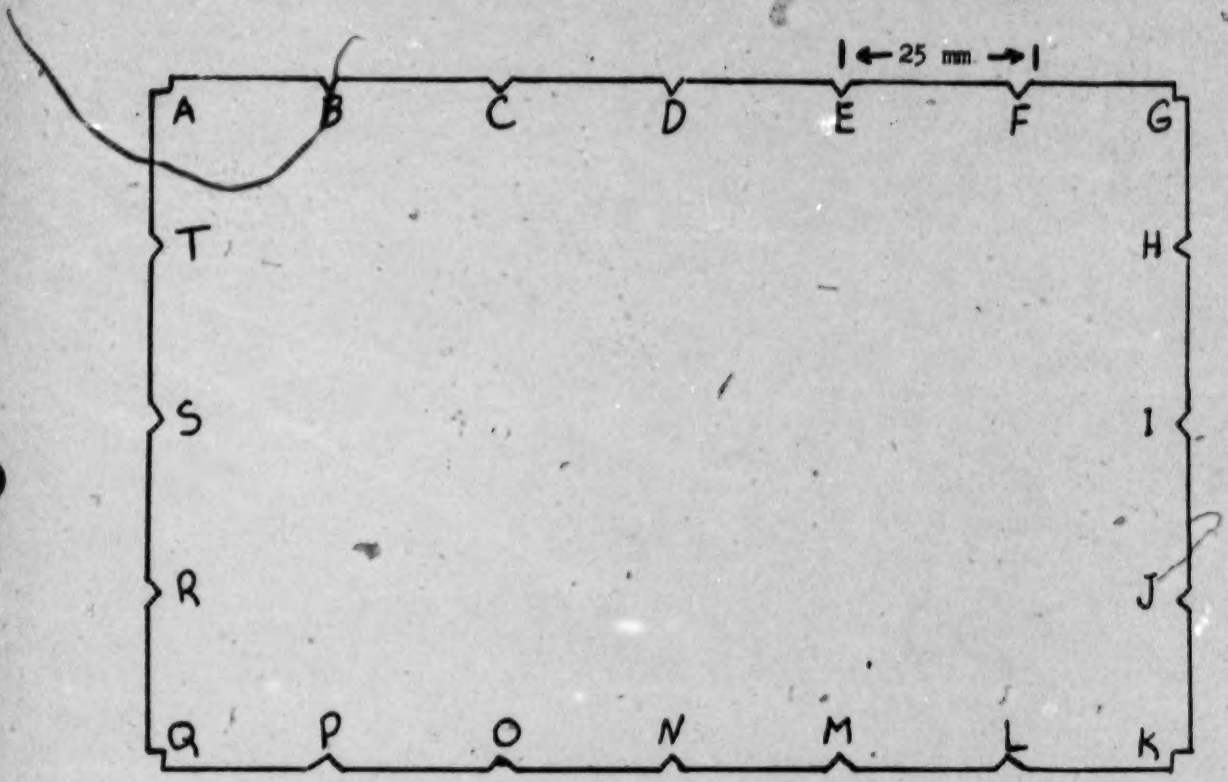

Figure 1

Answer the questions on 4A.

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Rubber Bands and Angles

An acute angle is an angle which measures less than 90°. A right angle is an angle which measures 90°. An obtuse angle is an angle which measures greater than 90° and less than 180°.

Snap on two rubber bands to "make" the indicated angle, then answer the question.

1. Acute, obtuse or right angle?
   a. $\angle$ EOG
   b. $\angle$ TMC
   c. $\angle$ BND
   d. $\angle$ JSH
   e. $\angle$ TWI
   f. $\angle$ TWH

2. Estimate the size of each angle. Measure and check your guess.
   a. $\angle$ SMF
   b. $\angle$ RJD
   c. $\angle$ ANC
   d. $\angle$ GMD
   e. $\angle$ DNK
   f. $\angle$ QCQ

3. Snap on $\overline{SI}$, then $\overline{RJ}$. Next, snap on $\overline{DP}$. Label the intersection of $\overline{SI}$ and $\overline{DP}$, U. Label the intersection of $\overline{RJ}$ and $\overline{DP}$, V.
   a. Measure $\angle$DUI and $\angle\overline{DVJ}$. What do you notice?
   b. Measure $\angle$ SUP and $\angle$ RVP. What do you notice?

4. Use three rubber bands to construct $\triangle$ QDK. "Snap on" $\overline{SI}$. Label the intersections of $\overline{SI}$, W and $\overline{QD}$ and $\overline{DK}$, X. Measure $\overline{WX}$. Measure $\overline{QK}$. What do you notice about the length of $\overline{WX}$ when compared to the length of $\overline{QK}$?

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Pick's Law

In 1899, G. Pick noticed a relationship among the number of grid points on a polygon, the number of grid points inside the polygon, and the area of the polygon. He used the relationship to write a formula for the area of a polygon in terms of grid points. To use his formula, the vertices of the polygon must be grid points.

Complete the table on 5A, then complete 5B.

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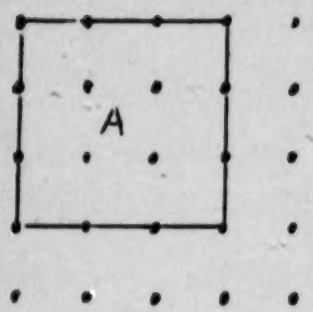
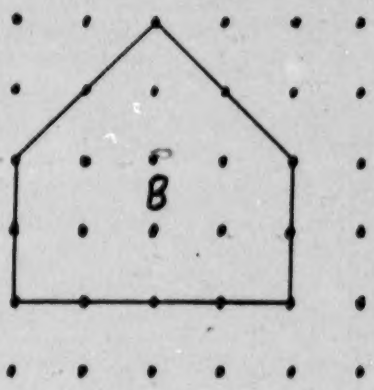
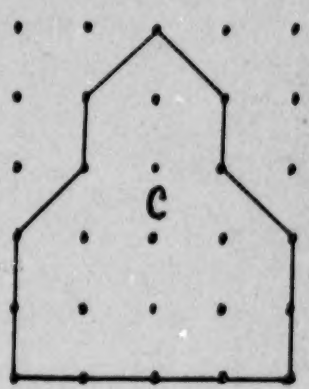
Pick's Law

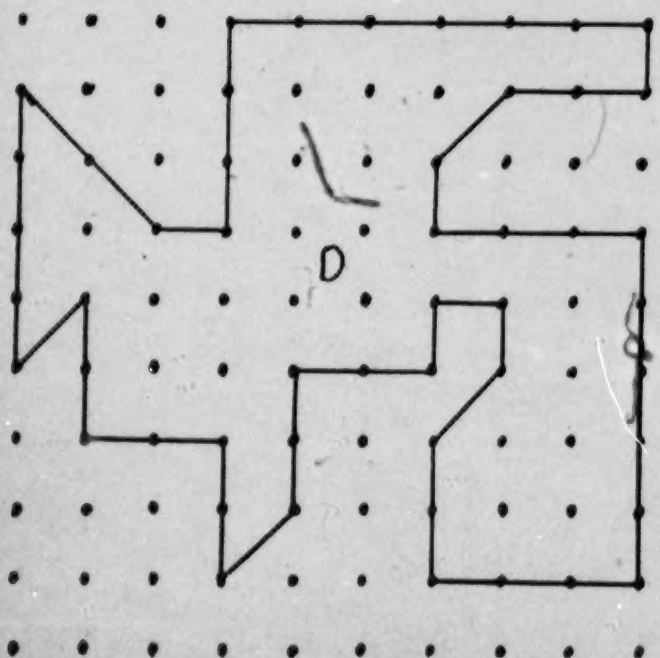
Use the figures shown to copy and complete the table.

Figure	Grid Points on the Polygon (p)	Grid Points inside the Polygon (i)	Area of the Polygon A
A	12	4	9
B	12	7	
C			14
D			
E			









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Pick's Law

Pick's formula is $A = \frac{1}{2} \times p + i - 1$. Check the formula for each figure in the table on 5A.

Refer to the polygons pictured on the grid. Use Pick's Law $A = \frac{1}{2} \times p + i - 1$ to complete Table 2. Check the areas by counting on the grids.

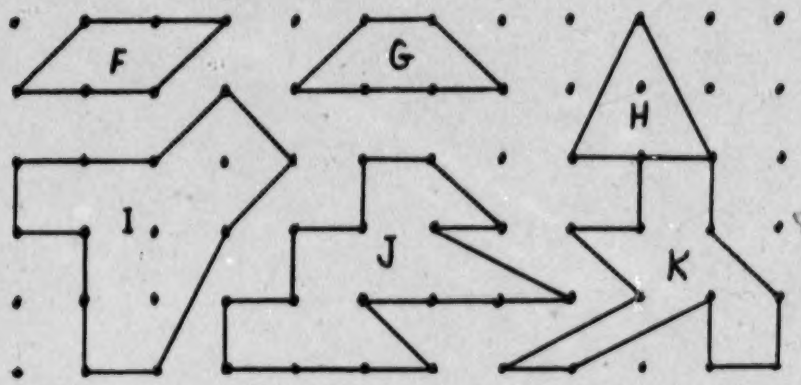

Figure	Grid Points on the Polygon (p)	Grid Points inside the Polygon (i)	Area of the Polygon A
F			2
G	6	0	
H		1	
I			
J			
K			

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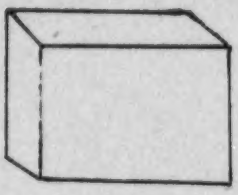
Intuitive Geometry 1

Materials: None

How many angles are there on a "cube"? You must use only the edges and corners.



Answer 1

There are 3 angles at each corner. There are 8 corners; thus, there are 24 angles.

Intuitive Geometry 2

Materials: None

1. Find out how many different numbers of intersections can be made using (a) 2 straight lines (b) 3 straight lines. (In each case assume that parallel lines have an intersection which is described as the empty set. Count this as one intersection.)
2. Can you find a rule to predict the solution for any number of straight lines up to 6?

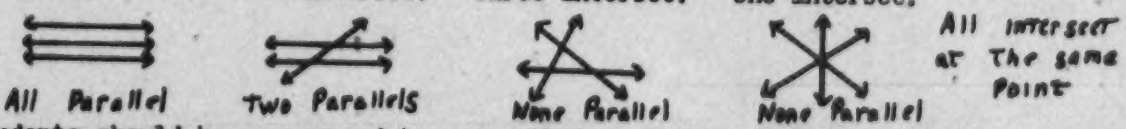
Answers 2

1(a) With 2 straight lines there are two possible solutions.

Zero intersections One intersection

(b) With 3 straight lines there are four possible solutions.

Zero intersec. Two intersec. Three intersec. One intersec.



2. Students should be encouraged to prove their rule by trial, if unable to show the generalization.

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Intuitive Geometry 3

Materials: Compass, straightedge, and paper

Using only a compass and a straightedge, how many angles can you construct with a known measure? (Remember, perpendicular lines form a right angle with a measure of 90°.)

Answer 3

Answers will vary. They should be able to construct the straight angle, right angle, 45° angle by bisecting the right angle, then halving that angle by bisecting, etc. They probably will construct a 60° angle by constructing an equilateral triangle. This and succeeding angles may then be constructed.

Intuitive Geometry 4

Materials:

Protractors
Rulers
Paper

Draw four polygons with 3 sides, 4 sides, 5 sides, and 6 sides. The sides need not be equal in length. Find the sum of the measures of the interior angles for each polygon. Make a table of your results. Is there a pattern?

Answer 4

# Sides (S)	Name of Polygon	Sum of Interior Angles (i)
3	triangle	180°
4	quadrilateral	360°
5	pentagon	540°
6	hexagon	720°

$i = (S - 2) \cdot 180$

S: number of sides; i: sum of interior angles

Materials: Cardboard, paper, compass, and scissors

Draw a circle on cardboard, then cut it out. On another piece of cardboard, draw a circle with a diameter equal to the radius of the first circle. Cut out this cardboard disc and mark a point on its edge. Place the disc around the inside of the circular cut-out.

Fig. 1

a. What is the path of the point traced out as the disc rotates?

b. Cut out another disc with a diameter equal to the radius of the first disc. Mark a point on its edge. What would be the path of the point on this second disc revolving inside the first disc during the experiment, assuming constant rates?

c. Try it with a circle equal to 1/3 the diameter of the original cut-out.

Answer

5

a. The path will be a straight line, Fig. A, (diameter) which passes through the center of the large circle.

Fig. A

b. The path would be a hypocycloid of four cusps, Fig. B, also called Astroid.

Note that since rates are constant, the second disc traces the same path regardless of the first disc.

Fig. B

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Pretest

Name_____

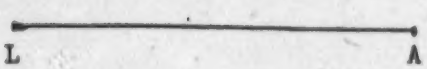
Score_____

Time_____

Students need a ruler which contains both metric and English units. They will also need a protractor.

Each answer is worth 4 points.

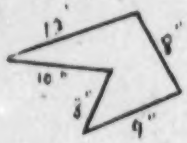
1. Measure the segment to the nearest



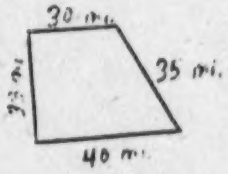
   a) centimeter
   b) millimeter
   c) inch

2. Find the perimeter of the polygon.

   a)



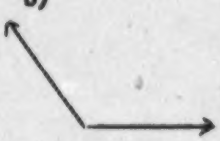
   b)



3. Measure each angle. Encircle the two which are congruent.

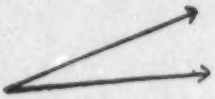
   a)

   b)



   c)

   d)



4. Draw an angle that has a measure of

   a) 97° b) 28° c) 45°

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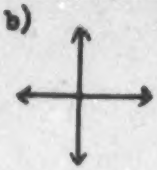
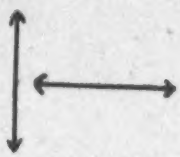
5. Are the lines parallel, perpendicular, or neither?

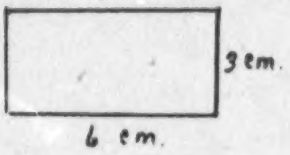
a)

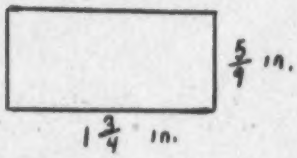
b) 

c) 

d)

6. The lengths of the sides of the rectangle are given. Find the area.

a) 

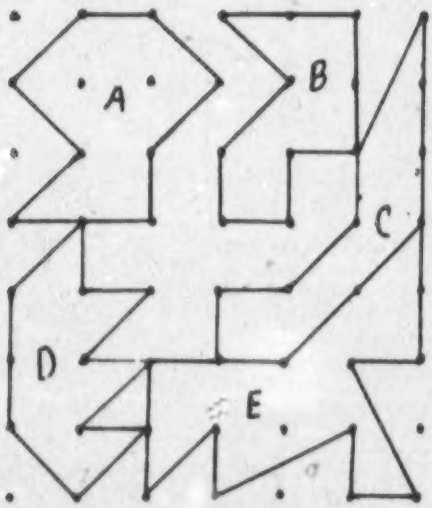
b) 

7. Find the area of the triangle in square centimeters by using the ruler and compass to find the base and height.

a)

b)

8. Pick's Law is $A = \frac{1}{2} n + i - 1$ where n is the number of grid points on the polygon and i is the number of grid points within the polygon. Use this law to find the areas of the polygons shown below.



Area of A =
B =
C =
D =
E =

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